

C L A I M S

[1] A cleaning method for cleaning a process chamber contaminated with metal in a substrate processing apparatus for performing a vacuum process on a substrate, the method comprising:

after the process, supplying a gas containing O<sub>2</sub> into the process chamber without setting the process chamber opened to the atmosphere, and generating plasma of the gas to clean the process chamber.

[2] The process chamber cleaning method according to claim 1, wherein the process on the substrate is an oxidation process on a substrate containing metal.

[3] The process chamber cleaning method according to claim 1, wherein the metal is tungsten.

[4] The process chamber cleaning method according to claim 1, wherein the process on the substrate is a plasma process.

[5] The process chamber cleaning method according to claim 4, wherein the plasma process on the substrate and the cleaning are performed by plasma generated by a planar antenna or plasma generated by an inductive coupling type.

[6] The process chamber cleaning method according to claim 4, wherein the plasma process on the substrate and the cleaning are performed by plasma generated by microwaves supplied into the process chamber through a planar antenna having a plurality of slots.

[7] The process chamber cleaning method according to claim 1, wherein the cleaning is performed by plasma of O<sub>2</sub> gas alone, or O<sub>2</sub> gas and an inactive gas.

5 [8] The process chamber cleaning method according to claim 1, wherein the cleaning is performed by plasma of O<sub>2</sub> gas and H<sub>2</sub> gas and an inactive gas, or O<sub>2</sub> gas and H<sub>2</sub> gas.

10 [9] The process chamber cleaning method according to claim 8, wherein the cleaning is performed by plasma having a ratio of H<sub>2</sub> gas relative to O<sub>2</sub> gas set at 2 or more.

15 [10] The process chamber cleaning method according to claim 8, wherein the cleaning is performed by plasma having a ratio of H<sub>2</sub> gas relative to O<sub>2</sub> gas set at 4 or more.

[11] The process chamber cleaning method according to claim 1, wherein the process chamber is heated by plasma prior to the cleaning.

20 [12] The process chamber cleaning method according to claim 1, wherein the substrate processing apparatus is arranged such that at least a part of a surface exposed to plasma is made of a dielectric material in the process chamber.

25 [13] A cleaning method for cleaning a process chamber in a substrate processing apparatus for performing a plasma process on a substrate having a metal-containing film, the method comprising:

after the process, supplying a gas containing O<sub>2</sub> into the process chamber without setting the process chamber opened to the atmosphere, and generating plasma of the gas to clean the process chamber.

5           [14] The process chamber cleaning method according to claim 13, wherein the metal-containing film is a tungsten-containing film.

          [15] The process chamber cleaning method according to claim 14, wherein the plasma process on the  
10       substrate having a metal-containing film is a selective oxidation process on a gate electrode including a tungsten-containing film and a poly-silicon film.

          [16] The process chamber cleaning method according to claim 13, wherein the plasma process on the  
15       substrate and the cleaning are performed by plasma generated by a planar antenna or plasma generated by an inductive coupling type.

          [17] The process chamber cleaning method according to claim 13, wherein the plasma process on the  
20       substrate and the cleaning are performed by plasma generated by microwaves supplied into the process chamber through a planar antenna having a plurality of slots.

          [18] The process chamber cleaning method according to claim 13, wherein the cleaning is performed by  
25       plasma of O<sub>2</sub> gas alone, or O<sub>2</sub> gas and an inactive gas.

          [19] The process chamber cleaning method according

to claim 13, wherein the cleaning is performed by plasma of O<sub>2</sub> gas and H<sub>2</sub> gas and an inactive gas, or O<sub>2</sub> gas and H<sub>2</sub> gas.

5 [20] The process chamber cleaning method according to claim 19, wherein the cleaning is performed by plasma having a ratio of H<sub>2</sub> gas relative to O<sub>2</sub> gas set at 2 or more.

10 [21] The process chamber cleaning method according to claim 19, wherein the cleaning is performed by plasma having a ratio of H<sub>2</sub> gas relative to O<sub>2</sub> gas set at 4 or more.

[22] The process chamber cleaning method according to claim 13, wherein the process chamber is heated by plasma prior to the cleaning.

15 [23] The process chamber cleaning method according to claim 13, wherein the cleaning is performed while temperature inside the process chamber is set to be about 400 to 800°C.

20 [24] The process chamber cleaning method according to claim 13, wherein the cleaning is performed while pressure inside the process chamber is set to be less than 126 Pa.

25 [25] The process chamber cleaning method according to claim 13, wherein the substrate processing apparatus is arranged such that at least a part of a surface exposed to plasma is made of a dielectric material in the process chamber.

[26] A computer program for execution on a computer, which, when executed by the computer, controls a substrate processing apparatus for performing a plasma process on a substrate having a metal-containing film, so as to execute a cleaning method for cleaning a process chamber in the substrate processing apparatus, wherein the method comprises, after the process, supplying a gas containing O<sub>2</sub> into the process chamber without setting the process chamber opened to the atmosphere, and generating plasma of the gas to clean the process chamber.

[27] A storage medium that stores a control program for execution on a computer, which, when executed by the computer, controls a substrate processing apparatus for performing a plasma process on a substrate having a metal-containing film, so as to execute a cleaning method for cleaning a process chamber in the substrate processing apparatus, wherein the method comprises, after the process, supplying a gas containing O<sub>2</sub> into the process chamber without setting the process chamber opened to the atmosphere, and generating plasma of the gas to clean the process chamber.

[28] A plasma processing apparatus comprising:  
a plasma supply source configured to generate plasma;  
a process container that defines a process chamber

for performing a process on a substrate by the plasma;

a substrate table configured to place the  
substrate thereon within the process container;

exhaust means for decreasing pressure inside the  
5 process container;

gas supply means for supplying a gas into the  
process container; and

a control section configured to conduct control to  
execute a cleaning method for cleaning a process  
10 chamber in a substrate processing apparatus for  
performing a plasma process on a substrate having a  
metal-containing film, wherein the method comprises,  
after the process, supplying a gas containing O<sub>2</sub> into  
the process chamber without setting the process chamber  
15 opened to the atmosphere, and generating plasma of the  
gas to clean the process chamber.

[29] A substrate processing method comprising:

cleaning a process chamber in a substrate  
processing apparatus for performing a plasma process on  
20 a substrate having a metal-containing film, wherein the  
cleaning comprises, after the process, supplying a gas  
containing O<sub>2</sub> into the process chamber without setting  
the process chamber opened to the atmosphere, and  
generating plasma of the gas to clean the process  
25 chamber; and

performing a plasma process on a substrate within  
the process chamber after the cleaning.

[30] A cleaning end point detecting method for detecting a cleaning end point when cleaning a process chamber by plasma of a cleaning gas in a plasma processing apparatus for performing a process on a substrate having a metal-containing film, the method comprising:

measuring emission intensity of radicals that increase with progress of cleaning within the process chamber, and detecting a cleaning end point from values thus obtained.

[31] The cleaning end point detecting method according to claim 30, wherein the cleaning gas is a gas containing at least hydrogen gas, and the radicals are hydrogen radicals.

[32] The cleaning end point detecting method according to claim 31, wherein the cleaning gas further contains oxygen gas.

[33] The cleaning end point detecting method according to claim 30, wherein the process on the substrate is an oxidation process on a substrate including the metal-containing film.

[34] The cleaning end point detecting method according to claim 30, wherein the metal-containing film is a tungsten-containing film.

[35] The cleaning end point detecting method according to claim 34, wherein an oxidation process on the substrate including the tungsten-containing film is

a selective oxidation process on a poly-silicon film of a laminated film including the tungsten-containing film and the poly-silicon film.

5 [36] The cleaning end point detecting method according to claim 35, wherein the selective oxidation process and the cleaning are performed by plasma generated by an inductive coupling type, plasma generated by a parallel-plate type, plasma generated by a planar antenna type, reflection wave plasma, or  
10 magnetron plasma.

[37] The cleaning end point detecting method according to claim 35, wherein the selective oxidation process and the cleaning are performed by plasma generated by microwaves supplied into the process  
15 chamber through a planar antenna having a plurality of slots.

[38] A cleaning method for cleaning a process chamber by plasma of a cleaning gas in a plasma processing apparatus for performing a process on a  
20 substrate having a metal-containing film formed thereon, the method comprising:

measuring emission intensity of radicals that increase with progress of cleaning within the process chamber, and detecting a cleaning end point from values  
25 thus obtained.

[39] The cleaning method according to claim 38, wherein the metal-containing film is a tungsten-



containing film.

[40] The cleaning method according to claim 38, wherein the method comprises, after the process on the substrate, supplying a cleaning gas into the process  
5 chamber without setting the process chamber opened to the atmosphere, and generating plasma of the cleaning gas to clean the process chamber.

[41] The process chamber cleaning method according to claim 38, wherein the cleaning is performed by  
10 plasma generated by an inductive coupling type, plasma generated by a parallel-plate type, plasma generated by a planar antenna type, reflection wave plasma, or magnetron plasma.

[42] The process chamber cleaning method according to claim 38, wherein the cleaning is performed by  
15 plasma generated by microwaves supplied into the process chamber through a planar antenna having a plurality of slots.

[43] A control program for execution on a computer, which, when executed by the computer, controls a plasma  
20 processing apparatus for performing a process on a substrate having a metal-containing film formed thereon, so as to execute a cleaning method for cleaning a process chamber in the plasma processing apparatus,  
25 wherein the method comprises measuring emission intensity of radicals that increase with progress of cleaning within the process chamber, and detecting a

cleaning end point from values thus obtained.

[44] A computer storage medium that stores a control program for execution on a computer, which, when executed by the computer, controls a plasma processing apparatus for performing a process on a substrate having a metal-containing film formed thereon, so as to execute a cleaning method for cleaning a process chamber in the plasma processing apparatus, wherein the method comprises measuring emission intensity of radicals that increase with progress of cleaning within the process chamber, and detecting a cleaning end point from values thus obtained.

[45] A plasma processing apparatus comprising:  
a plasma supply source configured to generate plasma;  
a process container that defines a process chamber for performing a process on a substrate by the plasma;  
a substrate table configured to place the substrate thereon within the process container;  
exhaust means for decreasing pressure inside the process container;  
gas supply means for supplying a gas into the process container; and  
a control section configured to conduct control to execute a cleaning method for cleaning a process chamber in a plasma processing apparatus for performing a process on a substrate having a metal-containing film

formed thereon, wherein the method comprises measuring  
emission intensity of radicals that increase with  
progress of cleaning within the process chamber, and  
detecting a cleaning end point from values thus  
5 obtained.